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Ephemerides of the Satellites of Saturn, 1884–85. By A. Marth.

(Continued from page 438.)

Differences of Right Ascension and Declination between the Satellites Titan, Hyperion, and Iapetus, and the Centre of Saturn.

		Titan.		*Hyperion.*		*Iapetus.*	
0^h Gr. 1884.		α_6-A s	δ_6-D ″	α_7-A s	δ_7-D ″	α_8-A s	δ_8-D ″
Nov.	1	+14·22	− 7·3	+ 3·05	−107·7	+35·33	+ 16·7
	2	+14·42	+ 27·7	+ 7·87	− 96·9	37·14	31·6
	3	+12·40	+ 58·4	+12·15	− 79·0	+38·72	+ 46·4
	4	+ 8·40	+ 79·9	+15·61	− 56·1	40·08	61·0
	5	− 3·02	+ 88·4	+18·12	− 29·1	+41·21	+ 75·2
	6	− 2·87	+ 82·2	+19·48	− 0·4	42·10	89·1
	7	− 8·29	+ 62·1	+19·63	+ 28·4	+42·74	+102·5
	8	−12·35	+ 31·6	+18·51	+ 55·4	43·12	115·4
	9	−14·41	− 4·2	+16·15	+ 78·7	+43·25	+127·6
	10	−14·17	− 39·4	+12·62	+ 96·5	43·12	139·1
	11	−11·75	− 68·7	+ 8·09	+106·7	+42·74	+149·8
	12	− 7·58	− 87·8	+ 2·87	+107·7	42·10	159·7
	13	− 2·29	− 94·3	− 2·63	+ 98·4	+41·20	+168·7
	14	+ 3·33	− 87·3	− 7·85	+ 78·7	40·05	176·6
	15	+ 8·48	− 68·0	−12·16	+ 49·7	+38·66	+183·6
	16	+12·46	− 38·8	−14·97	+ 14·6	37·04	189·5
	17	+14·61	− 4·1	−15·88	− 22·4	+35·19	+194·2
	18	+14·58	+ 31·4	−14·82	− 56·8	33·12	197·8
	19	+12·29	+ 62·0	−12·01	− 84·7	+30·85	+200·2
	20	+ 8·05	+ 82·8	− 7·91	−103·5	28·37	201·4
	21	+ 2·48	+ 90·1	− 3·03	−112·5	+25·72	+201·3
	22	− 3·50	+ 82·2	+ 2·13	−111·6	22·91	200·0
	23	− 8·92	+ 60·6	+ 7·14	−102·0	+19·95	+197·4
	24	−12·85	+ 28·7	+11·65	− 85·0	16·85	193·6
	25	−14·69	− 7·9	+15·37	− 62·3	+13·65	+188·5
	26	−14·19	− 43·3	+18·13	− 35·4	10·35	182·2
	27	−11·51	− 72·2	+19·72	− 6·3	+ 6·99	+174·7
	28	− 7·12	− 90·3	+20·07	+ 23·2	3·57	166·1
	29	− 1·68	− 95·4	+19·16	+ 51·3	+ 0·13	+156·4
	30	+ 4·01	− 87·0	+16·96	+ 76·0	− 3·32	+145·6
Dec.	1	+ 9·13	− 66·2	+13·55	+ 95·3	− 6·75	+133·8
	2	+12·95	− 35·7	+ 9·11	+107·3	10·13	121·1
	3	+14·87	− 0·3	+ 3·90	+110·2	−13·45	+107·6

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		Titan.		*Hyperion.*		*Iapetus.*	
0h Gr. 1884.		α_6-A s	δ_6-D ″	α_7-A s	δ_7-D ″	α_8-A s	δ_8-D ″
Dec.	4	+14·57	+35·3	−1·67	+102·8	16·68	93·3
	5	+12·02	+65·4	−7·06	+84·6	−19·79	+78·3
	6	+7·54	+85·1	−11·63	+56·8	22·77	62·8
	7	+1·83	+90·7	−14·77	+22·0	−25·60	+46·8
	8	−4·19	+81·3	−16·04	−15·5	28·25	30·4
	9	−9·51	+58·1	−15·29	−51·2	−30·71	+13·8
	10	−13·19	+25·3	−12·73	−80·8	32·95	−2·9
	11	−14·82	−11·8	−8·76	−101·7	−34·95	−19·7
	12	−14·04	−47·0	−3·92	−112·5	36·70	36·3
	13	−11·11	−75·0	+1·28	−113·4	−38·20	−52·7
	14	−6·53	−91·9	+6·38	−105·2	39·43	68·8
	15	−0·98	−95·5	+11·02	−89·2	−40·37	−84·4
	16	+4·67	−85·6	+14·90	−67·1	41·03	99·4
	17	+9·68	−63·4	+17·82	−40·7	−41·40	−113·7
	18	+13·30	−32·2	+19·60	−11·7	41·46	127·2
	19	+14·97	+3 6	+20·16	+18·1	−41·22	−139·8
	20	+14·39	+38·9	+19·43	+46·7	40·69	151·5
	21	+11·59	+68·1	+17·42	+72·1	−39·87	−162·1
	22	+6·93	+86·3	+14·20	+92·5	38·77	171·5
	23	+1·15	+90·4	+9·91	+105·9	−37·39	−179·7
	24	−4·83	+79·3	+4·82	+110·5	35·74	186·7
	25	−9·98	+55·0	−0·71	+105·0	−33·85	−192·3
	26	−13·47	+21·4	−6·14	+88·8	31·73	196·6
	27	−14·76	−15·6	−10·87	+62·6	−29·38	−199·6
	28	−13·72	−50·0	−14·26	+29·1	26·83	201·1
	29	−10·58	−77·0	−15·86	−8·3	−24·10	−201·2
	30	−5·87	−92·4	−15·44	−44·5	21·21	200·0
	31	−0·32	−94·5	−13·18	−75·3	−18·17	−197·4
1885. Jan.	1	+5·27	−83·2	−9·43	−97·8	−15·02	−193·4
	2	+10·10	−60·1	−4·74	−110·4	−11·77	−188·2
	3	+13·48	−28·4	+0·37	−113·0	8·45	181·6
	4	+14·88	+7·3	+5·49	−106·4	−5·08	−173·9
	5	+14·05	+42·0	+10·17	−91·8	−1·68	165·0
	6	+11·04	+69·8	+14·14	−70·9	+1·72	−155·1
	7	+6·28	+86·5	+17·17	−45·4	5·10	144·1
	8	+0·50	+89·0	+19·12	−17·1	+8·45	−132·2
	9	−5·33	+76·6	+19·87	+12·3	11·73	119·5
	10	−10·30	+51·4	+19·36	+40·8	+14·93	−106·0

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	Titan.		*Hyperion.*		*Iapetus.*	
0^h Gr. 1885.	α_6-A	δ_6-D	α_7-A	δ_7-D	α_8-A	δ_8-D
	s	″	s	″	s	″
Jan. 11	−13·52	+ 17·7	+17·59	+ 66·6	18·02	91·9
12	−14·54	− 18·9	+14·62	+ 87·7	+21·00	− 77·2
13	−13·28	− 52·4	+10·59	+102·3	23·84	62·0
14	− 9·98	− 77·9	+ 5·70	+108·6	+26·52	− 46·6
15	− 5·22	− 91·9	+ 0·33	+105·2	29·03	30·8
16	+ 0·28	− 92·6	− 5·05	+ 91·3	+31·35	− 14·9
17	+ 5·73	− 80·2	− 9·85	+ 67·5	33·48	+ 1·1
18	+10·35	− 56·5	−13·46	+ 35·7	+35·40	+ 17·1
19	+13·48	− 24·8	−15·36	− 0·5	37·10	32·9
20	+14·64	+ 10·4	−15·33	− 36·5	+38·57	+ 48·5
21	+13·60	+ 44·0	−13·44	− 68·0	39·81	63·8
22	+10·46	+ 70·5	−10·00	− 91·8	+40·81	+ 78·7
23	+ 5·65	+ 85·8	− 5·58	−106·1	41·56	93·1
24	− 0·05	+ 86·9	− 0·63	−110·7	+42·07	+106·9
25	− 5·74	+ 73·5	+ 4·37	−106·0	42·33	120·0
26	−10·45	+ 47·9	+ 9·02	− 93·3	+42·34	+132·4
27	−13·42	+ 14·4	+13·04	− 74·1	42·09	144·0
28	−14·21	− 21·4	+16·18	− 50·1	+41·60	+154·8
29	−12·77	− 53·7	+18·29	− 23·0	40·87	164·6
30	− 9·39	− 77·9	+19·26	+ 5·5	+39·90	+173·4
31	− 4·64	− 90·5	+19·03	+ 33·5	38·71	181·1
Feb. 1	+ 0·75	− 90·1	+17·55	+ 59·3	+37·29	+187·8
2	+ 6·03	− 77·0	+14·92	+ 80·9	35·66	193·4
3	+10·44	− 53·0	+11·20	+ 96·7	+33·82	+197·8
4	+13·34	− 21·6	+ 6·63	+104·8	31·79	201·0
5	+14·30	+ 12·8	+ 1·50	+103·7	+29·58	+203·0
6	+13·10	+ 45·2	− 3·75	+ 92·6	27·20	203·8
7	+ 9·89	+ 70·5	− 8·56	+ 71·6	+24·67	+203·4
8	+ 5·11	+ 84·4	−12·36	+ 42·3	22·00	201·8
9	− 0·48	+ 84·4	−14·59	+ 8·2	+19·21	+198·9
10	− 5·97	+ 70·4	−15·01	− 27·3	16·31	194·9
11	−10·45	+ 44·7	−13·57	− 59·2	+13·33	+189·7
12	−13·19	+ 11·7	−10·59	− 84·2	10·28	183·4
13	−13·81	− 23·1	− 6·50	−100·3	+ 7·17	+175·9
14	−12·26	− 54·2	− 1·81	−107·0	4·04	167·4
15	− 8·87	− 77·0	+ 3·02	−104·7	+ 0·89	+157·9
16	− 4·19	− 88·5	+ 7·61	− 94·3	− 2·25	147·5
17	+ 1·08	− 87·4	+11·65	− 77·2	− 5·37	+136·2

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0h Gr. 1885.		*Titan.*		*Hyperion.*		*Iapetus.*	
		α_6-A s	δ_6-D ″	α_7-A s	δ_7-D ″	α_8-A s	δ_8-D ″
Feb.	18	+ 6·17	− 73·9	+ 14·90	− 55·2	8·43	124·0
	19	+ 10·37	− 50·0	+ 17·20	− 29·7	− 11·43	+ 111·1
	20	+ 13·09	− 19·2	+ 18·42	− 2·4	14·35	97·5
	21	+ 13·89	+ 14·3	+ 18·50	+ 24·9	− 17·16	+ 83·4
	22	+ 12·61	+ 45·6	+ 17·40	+ 50·5	19·85	68·8
	23	+ 9·39	+ 69·3	+ 15·15	+ 72·7	− 22·40	+ 53·8
	24	+ 4·69	+ 82·5	+ 11·85	+ 89·6	24·79	38·5
	25	− 0·75	+ 81·8	+ 7·65	+ 99·6	− 27·02	+ 23·0
	26	− 6·05	+ 67·5	+ 2·82	+ 101·1	29·05	+ 7·5
	27	− 10·29	+ 42·1	− 2·25	+ 93·0	− 30·88	− 8·1
	28	− 12·90	+ 9·8	− 7·06	+ 75·3	32·50	23·5
Mar.	1	− 13·39	− 24·0	− 11·03	+ 49·0	− 33·89	− 38·7
	2	− 11·79	− 54·0	− 13·64	+ 16·9	35·06	53·6
	3	− 8·44	− 75·7	− 14·53	− 17·3	− 35·98	− 68·1
	4	− 3·86	− 86·4	− 13·63	− 49·2	36·66	82·1
	5	+ 1·25	− 84·7	− 11·16	− 75·4	− 37·08	− 95·4
	6	+ 6·17	− 71·1	− 7·50	− 93·4	37·26	108·0
	7	+ 10·20	− 47·6	− 3·13	− 102·6	− 37·18	− 119·9
	8	+ 12·77	− 17·4	+ 1·50	− 102·8	36·86	130·9
	9	+ 13·48	+ 15·1	+ 5·99	− 95·1	− 36·28	− 141·0
	10	+ 12·17	+ 45·3	+ 10·05	− 80·6	35·47	150·0
	11	+ 8·99	+ 68·4	+ 13·42	− 60·7	− 34·42	− 158·1
	12	+ 4·40	+ 80·5	+ 15·93	− 37·1	33·14	165·0
	13	− 0·90	+ 79·3	+ 17·44	− 11·2	− 31·65	− 170·8
	14	− 6·02	+ 65·0	+ 17·88	+ 15·2	29·96	175·4
	15	− 10·14	+ 40·0	+ 17·19	+ 40·6	− 28·07	− 178·9
	16	− 12·57	+ 8·5	+ 15·39	+ 63·3	26·01	181·2
	17	− 13·00	− 24·2	+ 12·53	+ 81·4	− 23·78	− 182·2
	18	− 11·41	− 53·2	+ 8·74	+ 93·4	21·41	182·1
	19	− 8·12	− 74·1	+ 4·25	+ 97·7	− 18·92	− 180·8
	20	− 3·66	− 84·2	− 0·61	+ 92·9	16·31	178·4
	21	+ 1·30	− 82·3	− 5·39	+ 78·7	− 13·60	− 174·8
	22	+ 6·07	− 68·9	9·54	+ 55·7	10·82	170·1
	23	+ 9·97	− 45·8	− 12·52	+ 26·1	− 7·98	− 164·4
	24	+ 12·44	− 16·4	− 13·93	− 6·6	5·11	157·7
	25	+ 13·10	+ 15·3	− 13·62	− 38·4	− 2·21	− 150·0
	26	+ 11·81	+ 44·6	− 11·71	− 65·7	+ 0·69	141·5
	27	+ 8·70	+ 66·9	− 8·54	− 85·8	+ 3·58	− 132·2

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	Titan.		*Hyperion.*		*Iapetus.*	
0^h Gr. 1885.	α_6-A	δ_6-D	α_7-A	δ_7-D	α_8-A	δ_8-D
	s	"	s	"	s	"
Mar. 28	+ 4·22	+ 78·5	− 4·55	− 97·5	6·44	122·1
29	− 0·94	+ 77·2	− 0·16	−100·6	+ 9·24	−111·3
30	− 5·91	+ 63·1			11·98	99·9
31	− 9·90	+ 38·6			+14·65	− 88·0
Apr. 1	−12·26	+ 7·9			17·22	75·6
2	−12·71	− 24·0			+19·67	− 62·8
3	−11·11	− 52·2			22·00	49·7
4	− 7·91	− 72·5			+24·20	− 36·4
5	− 3·58	− 82·2			26·26	23·0
6	+ 1·25	− 80·3			+28·16	− 9·5
7	+ 5·89	− 67·2			29·89	+ 4·0
8	+ 9·70	− 44·6			+31·45	+ 17·4

Though, for the sake of uniformity, the places of *Hyperion* are here given to $0^s{\cdot}01$ and $0''{\cdot}1$, like those of *Titan* and *Iapetus*, it is to be understood that they may be considerably in error, and that they are merely intended to be sufficiently near the truth to serve the practical requirements of observers. Under present circumstances, and till an approximately correct theory of the disturbed motion of *Hyperion* can be established, a really accurate ephemeris cannot be given. The general effect of the attraction of *Titan* upon the orbit of *Hyperion* may indeed be considered as sufficiently developed; for the evidence of the published observations indicates that the line of apsides of the orbit of *Hyperion* shifts approximately with the line of conjunction of the two satellites, *Hyperion* being, when in conjunction with *Titan*, near the higher apsis of its orbit, or nearly at its greatest distance from *Saturn*. But a knowledge of the observations made during the last three oppositions, together with those of some years to come, is required to allow more detailed inferences to be drawn. The mean conjunctions of the two satellites occur at intervals of 63·637 days in longitudes differing by $-3^\circ{\cdot}267$, so that the line of conjunction accomplishes a full retrograde revolution in longitude in 19·20 years, or, in reference to the lines of apsides of *Titan*, in 18·71 years, in which period 107 (or sometimes 108) conjunctions take place. The line of apsides of the orbit of *Hyperion* oscillates with regard to the line of conjunction, but for the proper determination of the amplitude of oscillation, the phase of which depends on the position of the apsis of *Titan*, sufficient accurate data are not yet available. To get these data, it is of importance that, in deducing the elements of the orbit for a number of epochs, only observations made during the six or seven weeks midway between two successive conjunctions should be used, since during this time the motion of *Hyperion* is not sensibly affected by *Titan*, and the

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elements may be treated as constant. It is only during the two or three weeks including the conjunction, that the alteration of the orbit of *Hyperion*, and especially the retrograde shifting of the apsis, is effected, and the observations made during this state of transition of the elements ought not (for the present) to be mixed up with those preceding or following, nor these with one another. It is, however, very desirable that the observations near the times of conjunctions should be specially attended to; and it will perhaps be most advantageous to observe the places of *Hyperion* at these times, not in reference to the centre of *Saturn*, but to *Titan* itself. During the period over which the present ephemeris extends the conjunctions of the two satellites occur 1884 Oct. 17, Dec. 20, and 1885 Feb. 21, this last being the 210th conjunction since the discovery of *Hyperion*.

Though the predicted places of *Titan* and *Iapetus* may not be much in error, it would be far more satisfactory if they could be founded upon better than makeshift elements. Observers must be good enough to publish all important series of observations of the satellites, if it is desired that the ephemerides should be up to the mark.

Sextant Observations of Comet Pons-Brooks, made on board the ship "British Envoy." By Capt. John P. Holdich, R.N.R.

(*Communicated by Capt. H. Toynbee.*)

Date.	A.T.S.	Lat.	Long.	α Tauri.	α Argus.	α Orionis.	α Ceti.
	P.M. h	S. ° ′	E. ° ′	° ′	° ′	° ′	° ′
Jan. 23	9·0	41 40	12 55	74 40	80 14		
26	8·55	44 9	23 50	73 16	85 27		47 0
31	8·55	41 50	44 45	72 28	67 46		
Feb. 3	9·5	42 30	57 45	72 5	64 14		
16	9·10	42 0	98 0		51 34	79 30	
20	9·5	41 20	114 0	73 10	49 12		
	9·0	41 5	118 40	73 20	48 50	78 40	
25	9 10	39 56	133 20	74 18	46 10		

Remarks.

Jan. 26 Better observations than before, comet brighter. Tail about 4° towards *α Ceti*.
Feb. 3 to 16 Moonlight too strong.
16 Tail hardly visible, and nucleus only when Moon is clouded.
20 Fair observations of nucleus. Tail barely visible, except with glasses.
25 Comet getting very indistinct to naked eye, and through glasses getting more the appearance of a nebulous cloud with bright centre.

Sextant observations corrected for index error.
Chronometer time was not taken.
Ship's position by D.R. from noon observations.